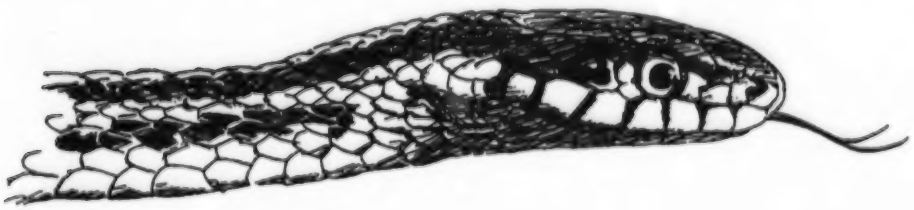
Red-sided Garter Snake (*Thamnophis sirtalis parietalis*)
Literature Review

Prepared by Kris Kendell

Submitted to Alberta Environmental Protection
Natural Resources Service
Fisheries and Wildlife Management Division



December 1998

100-03983/

ABSTRACT

The following literature review on the Red-sided Garter Snake (*Thamnophis sirtalis parietalis*) was prepared for Alberta Environmental Protection – Fisheries and Wildlife Management Division. The objective of the literature review was to acquire information on garter snake ecology, and summarize information on effective historic and present translocation techniques and practices. Due to the similarities in natural history, ecology and behavior of many snake species, literature research was not limited to *Thamnophis sirtalis parietalis*. Other species of snakes included: *Thamnophis spp.*, the Smooth Snake (*Coronella austriaca*), the Prairie Rattlesnake (*Crotalus viridis*), and the Blue Racer (*Coluber constrictor foxii*). Topics investigated included garter snake ecology, translocation studies, and capture and marking techniques. From the evidence of an extensive literature search, little work has been devoted to garter snake translocation attempts. Research on other snake species that are more charismatic, or whose populations are less abundant and are considered at risk, are more complete. Studies involving translocation attempts and dispersal patterns of the Prairie Rattlesnake (*Crotalus viridis*) and the Blue Racer (*Coluber constrictor foxii*) are two examples. As a result, this literature search was expanded to encompass other snake species for which data pertinent to the topics currently under investigation were available, in an attempt to incorporate any applicable information. This report is comprised of two components: 1) literature obtained from journal articles, books, and other publications, and 2) personal communications from herpetologists across Canada and the United States. Hard copies of the literature reviewed in this document are currently held at Alberta Environmental Protection, O.S. Longman Building, Edmonton, Alberta. Alternately, hard copies of the material referenced can be located using the NEOS library service.

ACKNOWLEGEMENTS

I would first like to thank Alberta Environmental Protection – Fisheries and Wildlife Management Division for funding this research on the ecology, and the fascinating historic and current studies regarding the Red-sided Garter Snake. Also acknowledged is the in kind support of Alberta Environmental Protection and the Alberta Conservation Association. A special thanks is owed to Lisa Takats, Isabelle Richardson, Steve Brechtel, Bruce Treichel and Larry Powell for their editorial comments and support during the review process.

A number of individuals contributed valuable personal information and knowledge acquired through years of research and dedicated interest to this species. They include: Bob Mason (Oregon State University), Patrick Gregory (University of Victoria), Larry Powell (University of Calgary), Brian Ilnicki (Ducks Unlimited, Wainwright), Ron Larche (Manitoba Department of Natural Resources), Karl Larsen (University of Victoria), Anthony Russell (University of Calgary), Ben Porchuk (University of Guelph), Andrew Didiuk (Canadian Wildlife Service – Saskatchewan), Cam Goater (University of Lethbridge), Stan Orchard (Royal B.C. Museum) and Brett Donald (landowner - Stony Plain, Alberta).

Finally, I would like to thank Bill Koonz (NRS, Manitoba) and Robert Willson (University of Guelph) for providing contact information and Dr. Milton Ness (Veterinarian, Edmonton) for his clinical advice regarding scale clipping and PIT (Passive Integrated Transponder) tagging snakes.

TABLE OF CONTENTS

		Page
Abstract		i
Acknowledgements		ii
Disclaimer		iv
1.0	Introduction	1
2.0	Methods	3
3.0	Literature Review	4
4.0	Personal Communications	18
5.0	Synthesis	23
6.0	References	28

DISCLAIMER

The personal communications outlined herein are summaries of verbal discussions with knowledgeable individuals. These comments have not been reviewed and should not be referenced unless speaking to the individual. Contact information is outlined on page 22 of this document.

INTRODUCTION

The Red-sided Garter Snake (*Thamnophis sirtalis parietalis*) is one of three garter snake species that occur in Alberta. The other two species are the Plains Garter Snake (*Thamnophis radix*) and the Wandering Garter Snake (*Thamnophis elegans*).

Garter snakes were once considered a common and widespread species across much of their range. Today, the public and biologists alike perceive a long-term decline in garter snake numbers. In Alberta, all three garter snake species are currently listed as "Yellow A". Under this designation wildlife species merit extra attention due to long-term, declining populations (Alberta Wildlife Management Division 1996a).

Snakes and other reptiles are poikilothermic (body temperature changes with their surroundings), and are unable to regulate their own body temperature. As a result reptiles that occur in climates that experience freezing temperatures must hibernate in order to survive. Snakes typically hibernate in dens called hibernacula, where they frequently congregate in large numbers representing a large proportion of the population in a given area. These populations of snakes often share favourable den locations with other snake species. Communal den sites provide snakes with a safe, humid place to spend the winter, where temperatures remain above freezing due to the insulating effects of the ground. Hibernacula are often found in areas with a rocky subsurface and naturally occurring pits, fissures or crevices. Snakes also choose rocky outcrops or sinkholes, burrows of small to medium size mammals and occasionally people's cellars, as over-wintering sites.

This dependency on over-wintering den sites leave snake populations vulnerable to disturbance, degradation and extirpation. The Red-sided Garter Snake is classified as a non-licence species, and under the Alberta Wildlife Act it is not afforded protection from harassment and attempt to injure or kill. Under the Alberta Wildlife Act, hibernacula are protected from disturbance and destruction from 1 September to 30 April (Alberta Environmental Protection 1996b).

In April 1998, Fish and Wildlife received a complaint call from landowners about a snake hibernaculum located on the front lawn of their property. For various reasons, the

landowners felt it was in their best interest to remove the snakes from the property. Alberta Environmental Protection and Alberta Conservation Association biologists made a decision to relocate the unwanted snakes to an existing, active hibernaculum, close to the original site. Upon completing an extensive search of the Alberta Snake Hibernaculum Inventory records, a relocation site was chosen in an abandoned gravel pit approximately six miles to the east of the original site. The relocation site was chosen on the basis of similar vegetation, geology and topography as well as relatively close proximity and assurance of long-term protection by the landowner. In addition, this site is already in use as a den by conspecifics. This Red-sided Garter Snake translocation project was initiated in the fall 1998 and is ongoing.

This literature review document provides a compilation of current and historic literature relating to the subject of garter snake and snake ecology, and snake translocation studies. The information contained in the references compiled in this document will be used to help increase our understanding and knowledge of garter snake ecology as it relates to the Red-sided Garter Snake translocation project. In addition, information on translocation projects and techniques within these references will aid in the success of future translocation studies by: 1) identifying possible sources of error in study designs, 2) providing effective and efficient methods of capturing and marking snakes, and 3) providing key information on hibernation and hibernaculum ecology, and garter snake natural history as it relates to translocation projects.

METHODS

Information and research contained within this literature review was acquired through an extensive search of the NEOS library consortium (which included the use of the Gate catalogue and CD-ROM databases of various government, college and university libraries) at the University of Alberta. Materials not held at the University of Alberta where obtained using the interlibrary loan service. Literature and information was also obtained through personal communications with herpetologists and biologists throughout North America (see disclaimer, page iv).

Topics researched included: relocation and translocation studies, hibernaculum and hibernation ecology, individual and population ecology, movements and habitat use, reproduction and diet, capture and marking techniques and practices, ecological physiology, life history parameters, spring emergence ecology, orientation abilities and mechanisms (chemical ecology), freeze tolerance and thermal regulation. Due to extensive overlap in subject matter between references, the references are ordered alphabetically by author and date in the literature review. In addition, pertinent literature is summarized by broad topics and listed alphabetically by author and date.

LITERATURE REVIEW

Aleksiuk, M. 1970. The effects of *in vivo* light and temperature acclimation on *in vivo* responses of heart rate to temperature in a cold-climate reptile, *Thamnophis sirtalis parietalis*. Canadian Journal of Zoology 48: 1155-1161.

Aleksiuk, M. 1971. Temperature-dependent shifts in the metabolism of a cool temperature reptile, *Thamnophis sirtalis parietalis*. Comparative Biochemistry and Physiology 39: 95-503.

Aleksiuk, M. 1976a. Reptilian hibernation: evidence of adaptive strategies in *Thamnophis sirtalis parietalis*. Copeia: 170-178.

Aleksiuk, M. 1976b. Metabolic and behavioral adjustments to temperature changes in the red-sided garter snake (*Thamnophis sirtalis parietalis*): an integrated approach. Journal of Thermal Biology 1: 153-156.

Aleksiuk, M., and P. T. Gregory. 1974. Regulation of seasonal mating behaviour in *Thamnophis sirtalis parietalis*. Copeia: 681-689.

Aleksiuk, M., and K. W. Stewart. 1971. Seasonal changes in the body composition of the garter snake (*Thamnophis sirtalis parietalis*) at northern latitudes. Ecology 52: 485-490.

Arnold, S. J. 1992. Behavioural variation in natural populations 6: Prey responses by two species of garter snakes in three regions of sympatry. Animal Behaviour 44(4): 705-719.

Arnold, S. J., C. R. Peterson, and J. Gladstone. 1995 Behavioural variation in natural populations 7: Maternal body temperature does not affect juvenile thermoregulation in a garter snake. Animal Behaviour 50(3): 623-633.

Bailey, R. M. 1949. Temperature tolerance of garter snakes in hibernation. Ecology 30: 238-242.

Blanchard, F. N., and F. C. Blanchard. 1941. Factors determining time of birth in the garter snake *Thamnophis sirtalis sirtalis* (Linnaeus). Michigan Academy of Science 26: 161-176.

Blanchard, F. N., and F. C. Blanchard. 1942. Mating of the garter snake *Thamnophis sirtalis sirtalis* (Linnaeus). Pap. Mich. Acad. Arts Sci. Lett. 27: 215-229.

Blanchard, F. N., and E. B. Finster. 1933. A method of marking living snakes for future recognition, with a discussion of some problems and results. Ecology 14: 334-347.

Braithwaite, A. C. 1995. Pilot study for smooth snake *Coronella austriaca* species recovery program. English Nature Research Reports 138: 1-36.

Brenner, F. J., E. K. Brenner, and P. E. Brenner. 1992. Analysis of drift fence arrays as a census method for vertebrate communities on a proposed mine site. Journal of the Pennsylvania Academy of Science 65(3): 117-122.

Brodie, E. D.III. 1993. Consistency of individual differences in anti-predator behaviour and colour pattern in garter snake, *Thamnophis ordinoides*. Animal Behaviour 45(5): 851-861.

Brown, W. S. 1976. A ventral scale clipping system for permanently marking snakes (Reptilia, Serpentes). Journal of Herpetology 10: 247-249.

Burke, R. L. 1991. Relocation, repatriations, and translocations of amphibians and reptiles: taking a broader view. Herpetologica 47(3): 350-357.

Campbell, H. W., and S. P. Christman. 1982. Field techniques for herpetofauna community analysis. Herpetological Communities 13: 193-195.

Carpenter, C. C. 1952. Comparative ecology of the common garter snake (*Thamnophis s. sirtalis*), the ribbon snake (*Thamnophis s. sauritus*), and Butler's garter snake (*Thamnophis butleri*) in mixed populations. Ecological Monographs 22: 235-258.

Carpenter, C. C. 1953. A study of hibernacula and hibernating association of snakes and amphibians in Michigan. Ecology 34: 74-80.

Chan, J. 1993. Evaluation of methods to reduce road mortality of red-sided garter snakes at Narcisse wildlife management area. University of Manitoba, MAI 32/05. Pp. 1356-1474.

Charland, M. B. 1995. Thermal consequences of reptilian viviparity: thermoregulation in gravid and nongravid garter snakes (*Thamnophis*). Journal of Herpetology 29(3): 383-390.

Charland, M. B., and P. T. Gregory. 1995. Movements and habitat use in gravid and nongravid female garter snakes (Colubridae: *Thamnophis*). Journal of Zoology (London) 236(4): 543-561.

Chieffelin, C. D., and A. De Queiroz. 1991. Temperature and defense in the common garter snake: warm snakes are more aggressive than cold snakes. Herpetologica 47(2): 230-237.

Churchill, T. A., and K. B. Storey. 1991. Metabolic responses to freezing by garter snakes. Cryo-Letters 12(6): 359-366.

Churchill, T. A., and K. B. Storey. 1992. Freezing survival of the garter snake *Thamnophis sirtalis parietalis*. Canadian Journal of Zoology 70(1): 99-105.

Cook, F. R. 1961. Garter snakes. Blue Jay 19: 54.

Cook, F. R. 1984. Introduction to Canadian amphibians and reptiles. National Museum of Canada, Ottawa, ON. 200 pp.

Costanzo, J. P. 1986. Influence of hibernaculum microenvironment on the winter life history of the garter snake (*Thamnophis sirtalis*). Ohio Journal of Science 86: 199-204.

Costanzo, J. P. 1988. Recovery from ice entombment in garter snakes. Herpetological Review 19: 76-77.

Costanzo, J. P. 1989a. Conspecific scent trailing by garter snakes (*Thamnophis sirtalis*) during autumn: further evidence for use of pheromones in den location. Journal of Chemical Ecology 15(11): 2531-2538.

Costanzo, J. P. 1989b. Effects of humidity, temperature, and submergence behavior on survivorship and energy use in hibernating garter snakes, *Thamnophis sirtalis*. Canadian Journal of Zoology 67(10): 2486-2492.

Costanzo, J. P. 1989c. A physiological basis for prolonged submergence in hibernating garter snakes *Thamnophis sirtalis*: evidence for an energy-sparing adaptation. Physiological Zoology 62: 580-592.

Costanzo, J. P., and D. L. Claussen. Natural freeze tolerance in a reptile. Cryo-Letters 9: 380-385.

Crews, D., and W. R. Garstka. 1982. The ecological physiology of a garter snake. Scientific American 247: 159-166.

Dalrymple, G. H., T. M. Steiner, R. J. Nodell, and F. S. Bernardino Jr. 1991. Seasonal activity of the snakes of Long Pine Key, Everglades National Park (Florida, USA). Copeia 2: 294-302.

Dargan, L. M., and W. H. Stickel. 1949. An experiment with snake trapping. Copeia 4: 264-268.

Dodd, K. C. Jr., and R. A. Seigel. 1991. Relocation, repatriation, and translocation of amphibians and reptiles: are they conservation strategies that work? Herpetologica 47(3): 336-350.

Doughty, P. 1994. Critical thermal minima of garter snakes (*Thamnophis*) depend on species and body size. Copeia (2): 537-540.

Ducks Unlimited Canada. 1993. Nature notes – red-sided garter snakes. Ducks Unlimited Canada Conservator 14(1): 1-24.

Ferner, J. W. 1979. A review of marking techniques for amphibians and reptiles. Herpetological Circular (9): 20-25.

Fisher, S. 1998. Snake Stalkers. Pp. 26-29 *in* Canadian Wildlife – species at risk. Canadian Wildlife Federation, Malcolm Publishing Inc., Montreal, PQ.

Fitch, H. S. 1951. A simple type of funnel trap for reptiles. Herpetologica 7: 77-79.

Fitch, H. S. 1965. An ecological study of the garter snake, *Thamnophis sirtalis*. University of Kansas Museum of Natural History 15: 493-564.

Fitch, H. S. 1980. *Thamnophis sirtalis* (Linnaeus). Common garter snake. Cat. Amer. Amphib. Rept. 270: 1-4.

Ford, N. B. 1982. Species specificity of sex pheromone trails of sympatric and allopatric garter snakes (*Thamnophis*). Copeia 1: 10-13.

Ford, N. 1986. The role of pheromone trails in the sociobiology of snakes. *In* (Duvall, D., D. Muller-Schwarze, and R. Silverstein, eds.). Chemical Signals in Vertebrates 4: 261-278.

Froom, B. 1972. The snakes of Canada. McClelland and Stewart Limited. Toronto/Montreal, ON. 200 pp.

Garstka, W. R., B. Camazine, and D. Crews. 1982. Interactions of behavior and physiology during the annual reproductive cycle of the red-sided garter snake, *Thamnophis sirtalis parietalis*. Herpetologica 38: 104-123.

Gillingham, J. C., and C. C. Carpenter. 1978. Snake hibernation: construction of and observations on a manmade hibernaculum (Reptilia Serpentes). Journal of Herpetology 12: 495-498.

Gosselin, H. M., and B. R. Johnson. 1995. The urban outback – wetlands for wildlife: a guide to wetland restoration and frog friendly backyards. Metro Toronto Zoo, Scarborough, ON. 3 pp.

Graves, B. M., and D. Duvall. 1990. Spring emergency patterns of wandering garter snakes and prairie rattlesnakes in Wyoming (USA). Journal of Herpetology 24(4): 351-356.

Graves, B. M., D. Duvall, M. B. King, S. L. Lindstedt, and W. A. Gern. 1986. Initial den location by neonatal prairie rattlesnakes: function, causes, and natural history in chemical ecology. Chemical Signals in Vertebrates 4: 285-304.

Graves, B. M., M. Halpern, and J. C. Gillingham. 1993. Effects of vomeronasal system deafferentation on home range use in a natural population of eastern garter snakes, *Thamnophis sirtalis*. Animal Behaviour 45(2): 307-311.

Gregory, P. T. 1974a. Life history parameters of a population of red-sided garter snakes (*Thamnophis sirtalis parietalis*) adapted to a rigorous and fluctuating environment. PhD. dissertation, University of Manitoba, Winnipeg, MA.

Gregory, P. T. 1974b. Patterns of emergence of red-sided garter snake (*Thamnophis sirtalis parietalis*) in the Interlake region of Manitoba. Canadian Journal of Zoology 52(3): 1063-1069.

Gregory, P. T. 1975. Aggregations of gravid snakes in Manitoba, Canada. Copeia: 185-186.

Gregory, P. T. 1977. Life-history parameters of the red-sided garter snake (*Thamnophis sirtalis parietalis*) in an extreme environment, the Interlake region of Manitoba. Natl. Mus. Nat. Sci. Publ. Zool. 12: 1-44.

Gregory, P. T. 1982. Reptilian hibernation. Pp. 53-154 *in*: Biology of the Reptilia. (C. Gans and F.H. Pough, eds.). New York: Academic Press, Volume 13.

Gregory, P. T. 1983. Identification of sex of small snakes in the field. Herpetological Review 14: 42-43.

Gregory, P. T. 1984a. Communal denning in snakes. Pp. 57-75 *in* Contributions to Vertebrate Ecology and Systematics: A Tribute to Henry S. Fitch. (R.A. Seigel, and L.E. Hunt, J.L. Knight, L.A. Maralet, and N.L. Zuschlag, eds.). Univ. Kansas Mus. Nat. Hist., Spec. Publ. 10.

Gregory, P. T. 1984b. Correlations between body temperature and environmental factors and their variations with activity in garter snakes. Canadian Journal of Zoology 62(11): 2244-2249.

Gregory, P. T. 1984c. Habitat, diet, and composition of assemblages of garter snakes (*Thamnophis*) at eight sites on Vancouver Island. Canadian Journal of Zoology 62(10): 2013-2022.

Gregory, P. T. 1990. Temperature difference between head and body in garter snakes (*Thamnophis*) at a den in Central British Columbia (Canada). Journal of Herpetology 24(3): 241-245.

Gregory, P. T., and K. W. Larsen. 1993. Geographic variation in reproductive characteristics among Canadian populations of the common garter snake (*Thamnophis sirtalis*). Copeia 4: 946-958.

Gregory, P. T., and K. W. Larsen. 1996. Are there any meaningful correlates of geographic life-history variation in the garter snake, *Thamnophis sirtalis*? Copeia 1: 183-189.

Gregory, P. T., K. W. Larsen, and D. R. Farr. 1992. Snake litter size = live young + dead young + yolks. Herpetological Journal 2(4): 145-146.

Gregory, P. T., J. M. Macartney, and K. W. Larsen. 1987. Spatial patterns and movements. Pp. 366-395 *in* Snakes: Ecology and Evolutionary Biology (R. A. Seigel, J. T. Collins, and S. S. Novak, eds.). New York: Macmillan, NY.

Gregory, P. T., and K. J. Nelson. 1992. Predation on fish and intersite variation in the diet of common garter snakes, *Thamnophis sirtalis*, on Vancouver Island (Canada). Canadian Journal of Zoology 70(12): 2501.

Gregory, P. T., and C. T. Prelyphchan. 1994. Analysis of variance of first-year growth in captive garter snakes (*Thamnophis elegans*) by family and sex. Journal of Zoology (London) 232(2): 313-322.

Gregory, P. T., and K. W. Stewart. 1975. Long-distance dispersal and feeding strategy of the red-sided garter snake (*Thamnophis sirtalis parietalis*) in the Interlake of Manitoba. Canadian Journal of Zoology 53: 238-245.

Hawley, A. W. L., and M. Aleksiuk. 1975. Thermal regulation of spring mating behavior in the red-sided garter snake (*Thamnophis sirtalis parietalis*). Canadian Journal of Zoology 53: 768-776.

Heller, S., and M. Halpern. 1981. Laboratory observations on conspecific and congeneric scent trailing in garter snakes (*Thamnophis*). Behavior Neural Biology 33(3): 372-377.

Hermes, L. M., and K. B. Storey. 1993a. Antioxidant defences in the tolerance of freezing and anoxia by garter snakes. American Journal of Physiology 265(3) part 2: R646-R652.

Hermes, L. M., and K. B. Storey. 1993b. In vitro oxidative inactivation of glutathione S-transferase from a freeze tolerant reptile. Molecular and Cellular Biochemistry 124(2): 149-158.

Hirth, H. F. 1966. The ability of two species of snakes to return to a hibernaculum after displacement. The Southwest Naturalist 11: 49-53.

Hirth, H. F., R. C. Pendleton, A. C. King, and T. R. Downard. 1969. Dispersal of snakes from a hibernaculum in northwestern Utah. Ecology 50(2): 332-339.

Hudnall, J. A. 1982. New methods for measuring and tagging snakes. Herpetological Review 13: 97-98.

Jordan, O. R. 1967. The occurrence of *Thamnophis sirtalis* and *T. radix* in the prairie forest ecotone, west of Itasca State Park, Minnesota. Herpetologica 23: 303-308.

Joy, J. E., and D. Crews. 1985. Social dynamics of group courtship behavior in male red-sided garter snakes (*Thamnophis sirtalis parietalis*). Journal of Comparative Psychology 99: 145-149.

Joy, J. E., and D. Crews. 1986. Hibernation in garter snakes (*Thamnophis sirtalis parietalis*): seasonal cycles of cold tolerance. Comparative Biochemistry and Physiology 87A: 1097-1101.

Joy, J. E., and D. Crews. 1988. Male mating success in red-sided garter snakes: size is not important. Animal Behaviour 36: 1839-1841.

Kaplan, M. 1996. Garter snakes: an overview of natural history and care in captivity. Litteratura Serpentium English Edition 16(3) 58-63.

Keck, M. B. 1994. Test for detrimental effects of PIT tags in neonatal snakes. Copeia 1: 226-228.

Kephart, D. G. 1981. Population ecology and population structure of *Thamnophis elegans* and *Thamnophis sirtalis*. PhD. Dissertations, University of Chicago, Chicago, IL.

Kephart, D. G., and S. J. Arnold. 1982. Garter snake diets in a fluctuating environment: a seven year study. Ecology 63: 1232-1236.

Koonz, W. H. 1991. Red-sided garter snake management plan. Manitoba Natural Resources, Wildlife Branch, 20 pp.

Kriuda, W. 1993. Road kills of migrating garter snakes in The Pas, Manitoba. Blue Jay 51(4): 197-198.

Krohmer, R. W., and D. Crews. 1987. Temperature activation of courtship behavior in the male red-sided garter snake (*Thamnophis sirtalis parietalis*): Role of the anterior hypothalamus – preoptic area. Behavioral Neuroscience 101(2): 228-236.

Krohmer, R. W., M. Grassman, and D. Crews. 1987. Annual reproductive cycle in the male red-sided garter snake, *Thamnophis sirtalis parietalis*: field and laboratory studies. General and Comparative Endocrinology 68(1): 64-75.

Larsen, K. W. 1986. Ecology of the common garter snake, *Thamnophis sirtalis*, at the northern limit of its range. M.Sc. Thesis, University of Victoria, Victoria, British Columbia. 112 pp.

Larsen, K. W. 1987. Movements and behavior of migratory garter snakes, *Thamnophis sirtalis*. Canadian Journal of Zoology 65: 2241-2247.

Larsen, K. W., and P. T. Gregory. 1989. Population size and survivorship of the common garter snake, *Thamnophis sirtalis*, near the northern limit of its distribution. Holarct. Ecology 12 (2): 81-86.

Larsen, K. W., P. T. Gregory, and R. Antoniak. 1993. Reproductive ecology of the common garter snake *Thamnophis sirtalis* at the northern limit of its range. American Midland Naturalist 129(2): 336-345.

Larsen, K. W., and J. F. Hare. 1992. Criddle's riddle: where do young garter snakes hibernate? Herpetological Review 23: 39-41.

Lawson, P. A. 1989. Orientation abilities and mechanisms in a northern migratory population of the common garter snake (*Thamnophis sirtalis*). Musk-Ox 37: 110-115.

Lawson, P. A. 1991. Movement patterns and orientation mechanisms in garter snakes (*Thamnophis*, snakes). PhD. dissertation, University of Victoria, Victoria, BC. 180 pp.

Lawson, P. A. 1994. Orientation abilities and mechanism in nonmigratory populations of garter snakes (*Thamnophis sirtalis* and *T. ordinoides*). Copeia 1994(2): 263-274.

Lawson, P. A., and D. M. Secoy. 1991. The use of solar cues as migratory orientation guides by the plains garter snake, *Thamnophis radix*. Canadian Journal of Zoology 69(10): 2700-2702.

Lewke, R. R. and R. K. Stroud. 1974. Freeze branding as a method of marking snakes. Copeia 1974: 997-1000.

Lillywhite, H. B. 1982. Tracking as an aid in ecological studies of snakes. Pp. 181-191 *in* Herpetological Communities. (N.J. Scott, Jr. ed.). United States Department of the Interior, Fish and Wildlife Service, Wildlife Research Report 13. Washington, DC.

Lutterschmidt, W. I. 1994. The effect of surgically implanted transmitters upon the locomotory performance of the checkered garter snake, *Thamnophis marcianus marcianus*. Herpetological Journal 4(1): 11-14.

Macartney, J. M., K. W. Larsen, and P. T. Gregory. 1989. Body temperature and movements of hibernating snakes (*Crotalus* and *Thamnophis*) in relation to changes in the thermal gradient of natural hibernacula. Canadian Journal of Zoology 67: 108-114.

MacMillan, S. 1988. Young of the year red-sided garter snakes (*Thamnophis sirtalis parietalis*) at communal dens in Manitoba's Interlake region. Herpetological Review 19: 8-9.

MacMillan, S. 1995. Restoration of an extirpated red-sided garter snake *Thamnophis sirtalis parietalis* population in the Interlake region of Manitoba, Canada. Biological Conservation 72(1): 13-16.

Manjarrez, J., and H. Drummond. 1996. Temperature-limited activity in the garter snake *Thamnophis melanogaster* (Colubridae). Ethology 102(2): 146-156.

Mason, R. T. 1993. Chemical ecology of the red-sided garter snake, *Thamnophis sirtalis parietalis*. Brain Behavior and Evolution 41(3-5): 261-268.

Mason, R. T., T. H. Jones, H. M. Fales, L. K. Pannell, and D. Crews. 1990. Characterization, synthesis, and behavioral responses to sex attractiveness pheromones of red-sided garter snakes (*Thamnophis sirtalis parietalis*). Journal of Chemical Ecology 16(7): 2253-2369.

McNally, J., T. A. Hare, and J. Jarchow. 1996. Evaluation of a rattlesnake relocation program. Tucson Herpetological Society, Tuscon, Arizona, 3 pp.

Mendonca, M. T., and D. Crews. 1989. Effect of fall mating on ovarian development in the red-sided garter snake. American Journal of Physiology 257(6) part 2: R1548-R1550.

Mendonca, M. T., A. J. Tousignant, and D. Crews. 1996. Pinealectomy, melatonin, and courtship behavior in male red-sided garter snakes (*Thamnophis sirtalis parietalis*). Journal of Experimental Zoology 274(1): 64-74.

Nero, R. W. 1957. Observations at a garter snake hibernaculum. Blue Jay 15: 116-118.

Passek, K. M. 1997. Thermal influence on defensive behaviours of the eastern garter snake, *Thamnophis sirtalis*. Animal Behaviour 54(3): 629-633.

Peterson, C. R. 1987. Daily variation in the body temperatures of free-ranging garter snakes. Ecology 68(1): 160-169.

Porchuk, B., 1997. Ecology and conservation of the endangered blue racer (*Coluber constrictor foxii*) on Pelee island, Canada (Ontario). University of Guelph. 182 pp.

Preston, W. B. 1982. The amphibians and reptiles of Manitoba. Manitoba Museum of Man and Nature, Winnipeg, MB. 128 pp.

Reinert, H. K. 1991. Translocation as a conservation strategy for amphibians and reptiles: some comments, concerns, and observations. Herpetologica 47(3): 357-363.

Rosen, P. C. 1991. Comparative field study of thermal preferenda in garter snakes (*Thamnophis*). Journal of Herpetology 25(3): 301-312.

Rossman, D. A., N. B. Ford, and R. A. Seigel. 1996. The garter snakes: evolution and ecology. University of Oklahoma Press, Norman and London i-xx. 332 pp.

Russell, A. P., and A. M. Bauer. 1993. The amphibians and reptiles of Alberta. The University of Calgary Press and the University of Alberta Press, Calgary/Edmonton, Alberta. 264 pp.

Schwartz, J. M., G. F. McCracken, and G. M. Burghardt. 1989. Multiple paternity in wild populations of the garter snake, *Thamnophis sirtalis*. Behavioral Ecology and Sociobiology 25(4): 269-274.

Sexton, O. J., and J. E. Bramble. 1994. Post-hibernation behavior of a population of garter snakes (*Thamnophis sirtalis*). Amphibia- Reptilia 15(1): 9-20.

Spalding, D. A. E. 1973. Garter snakes. Natural History Division Provincial Museum Archives Alberta. Ref. List Number 120. 3 pp.

Stark, M. A. 1985. A simple technique for trapping prairie rattlesnakes during spring emergence. Herpetological Review 16: 76-77.

Stark, M. A. 1986. Implanting long-range transmitters in prairie rattlesnakes, *Crotalus v. viridis*. Herpetological Review 17: 17-18.

Stebbins, R. C. 1985. A field guide to western reptiles and amphibians. Houghton Mifflin Company, Boston, MS. 336 pp.

Storey, K. B., and J. M. Storey. 1997. Adaptations for freezing survival in ectothermic vertebrates. Advances in Molecular and Cell Biology 19: 1-32.

Szaro, R. C., S. C. Belfit, J. K. Aitkin, and R. D. Babb. 1988. The use of timed fixed area plots and mark-recapture technique in assessing riparian garter snake populations. US Forest Service General Technical Report RM 166. Pp. 239-246.

Takats, L. 1997. The distribution of garter snake hibernacula in Alberta. Edmonton Naturalist 25(3): 23-24.

van-het-Meer, J. 1996. A new method of breeding *Thamnophis* species. Litteratura Serpentium English Edition 16(4): 90-93.

Vincent, T. 1975. Body temperatures of *Thamnophis sirtalis parietalis* at the den site. Journal of Herpetology 9(2): 252-254.

Vincent, T. K. 1976. Cold resistance in the garter snake *Thamnophis sirtalis parietalis*. PhD. dissertation, University of Regina, Regina, SK.

Waters, R. M. 1993. Odorized air current trailing by garter snakes, *Thamnophis sirtalis*. Brain Behavior and Evolution 41(3-5): 219-223.

Waye, H. L., and P. T. Gregory. 1993. Choices of neonate *Thamnophis elegans vagrans* between conspecific, congeneric, and heterogeneric odors. Journal of Herpetology 27(4): 435-441.

Whitlock, I. 1995. Keeping and breeding garter snakes. Rephiberary 215: 4-6.

Whittier, J. M., and D. Crews. 1990. Body mass and reproduction in female red-sided garter snakes (*Thamnophis sirtalis parietalis*). Herpetologica 46(2): 219-226.

Whittier, J. M., R. T. Mason, and D. Crews. 1985. Mating in red-sided garter snakes, *Thamnophis sirtalis parietalis*: differential effects on male and female sexual behavior. Behavioral Ecology and Sociobiology 16(3): 257-261.

Wood, W. F., J. M. Parker, and P. J. Weldon. 1995. Volatile components in scent gland secretions of garter snakes (*Thamnophis* spp.). Journal of Chemical Ecology 21(2): 213-219.

Woodbury, A. M. 1951. Symposium: a snake den in Tooele County, Utah. Herpetologica 7(1): 4-14.

Zappalorti, R.T., and H. K. Reinert. 1994. Artificial refugia as a habitat improvement strategy for snake conservation. Pp 369-375 *in* Captive management and conservation of amphibians and reptiles - Society for the study of amphibians and reptiles (Murphy, J. B., K. Adler, and J. T. Collins), Ithaca, NY. Contributions to Herpetology 11.

Zappalorti, R. T., and G. Rocco. 1991. Use of man-made structures as summer dens and winter hibernacula by Corn Snakes (*Elaphe guttata*) and Pine Snakes (*Pituophis meleanoleucus*) in the Pine Barrens of southern New Jersey. Herpetological Associates, Inc. Forked River, New Jersey, NJ. 18 pp.

Personal Communications

Didiuk, Andrew – Canadian Wildlife Service, Saskatoon, Saskatchewan, 314 Egbert Avenue, Saskatoon, Saskatchewan S7N 1X1

Andrew sent information regarding trap design and techniques.

Donald, Brett – Freeway Enterprises Ltd., Box 45, Site 430, R.R. 4, Stony Plain, Alberta T7Z 1X4

Both Brett Donald (current landowner) and Michael Northcott (past landowner) contribute valuable personal knowledge regarding the period of activity at the hibernaculum, relative numbers of snakes, and general movements and occurrences of garter snakes in the area.

Both individuals observed and believed that the snakes from the hibernaculum in the gravel pit on Brett's land disperse in the direction of Kilini creek, which lies west of the den site. Abundant forest, with some wet areas, occurs in the area between the creek and the den.

Mike observes more snakes on Brett's property then on his own. His land occurs at a higher elevation, and consists of upland forest with little or no wet areas. In addition, Mike has indicated that in some years large numbers of snakes are killed as they bask on and cross the road south of the den site (indicating a direction of dispersal).

Brett estimates that the number of snakes that occupy the hibernaculum at the gravel pit is in the thousands. He reports seeing thousands of snakes in the spring congregating "knee deep" in a shallow depression at the base of the hill in which the hibernaculum occupies.

Brett Donald reports seeing snakes as late as October 21, 1998 at the gravel pit hibernaculum location.

Gregory, Patrick, T. – Department of Biology, University of Victoria, P.O. Box 3020, STN CSC, Victoria, British Columbia V8W 3N5

Patrick had no further information to contribute regarding garter snakes and the topics researched. The information obtained through researching the extensive papers and

studies authored and undertaken by Patrick accurately reflects his views and thoughts on the subjects investigated.

Ilnicki, Brian - Ducks Unlimited Canada, 930-6 Avenue Wainwright, Alberta T9W 1E2

Brian Ilnicki, along with Wayne Roberts (University of Alberta Museum) co-ordinated the Ducks Unlimited garter snake relocation and hibernaculum reconstruction project. Knowledge of the details regarding this project are based on personal communications with Brian Ilnicki.

The original hibernaculum was located under a porch that consisted of a concrete pad attached to a house. The subsurface under this concrete pad consisted of a variety of backfill materials such as gravel, rock and larger aggregates of concrete. The primary problem with the location of this hibernaculum was that snakes were gaining entry into the landowner's residence.

When the concrete pad (porch) was removed it was discovered that the snakes in the hibernaculum were seeking out and exploiting the warmth radiating from the foundation of the house.

A new hibernaculum was created approximately 200 m north of the original den site on the property. With the aid of heavy equipment a large hole was dug and back filled with gravel, rocks, pieces of concrete pipe, sticks and railway ties. In addition, back fill material was obtained from the original den site. The newly constructed den was then covered with sod and fenced (due to horses in the area).

On the September long weekend, snakes were hand captured from the original hibernaculum and placed in the new one. One-foot high screen drift fencing and 24 inch deep holes (with diameters of about 12-16 inches) were dug in efforts to capture snakes. Fencing was also used to contain snakes at the new den. The fencing, however, was found to be ineffective on the lawn, because snakes were able to crawl over and under it. Throughout the fall the property owners relocated snakes to the new den site. None of the snakes were marked in any way prior to relocating.

In the spring, following the relocation, snakes were observed at the newly constructed hibernaculum indicating that they successfully survived the winter. The next fall also yielded snakes at the new hibernaculum. Since then Brian has not personally surveyed the new den site, although Wayne Roberts has. According to Brian, this is the third fall since the project was undertaken, and since then little follow up has occurred. This project was never considered to be a long-term study by Ducks Unlimited; rather, it was commenced because DU was doing a lot of other work in the area, they knew the landowners, and the cost of the project was minimal.

Larche, Ronald, A. – Manitoba Department of Natural Resources, Wildlife Branch, Box 24, 200 Saulteaux Crescent, Winnipeg, Manitoba R3J 3W3

Ron has primarily conducted work on garter snakes that occur near the Narcisse Dens in Manitoba, Canada where large numbers (thousands) of snakes congregated each year to spend the winter. Ron has been involved with the problem of large number of snakes being killed due to vehicular traffic as they disperse and congregate at the den sites at Narcisse. Attempts to reduce road mortality involved erecting barriers, to divert snakes from crossing the road, to a culvert that runs under the road. These initiatives have had limited success, but discussions with the Manitoba Department of Highways and Transportation and further experimentation are ongoing.

Larsen, Karl – Department of Biology, University of Victoria, P.O. Box 3020, STN CSC, Victoria, British Columbia V8W 3N5

Karl Larsen has worked on garter snakes in the past and is currently studying the feasibility of relocating a rattlesnake population in British Columbia.

Karl Larsen suggests scale clipping no lower than the third scale from the vent. This is to help prevent any possible injuries to vital organs of the snakes, during the process of scale clipping. In addition, Karl recommended the use of eye surgery scissors due to their precision and high quality.

Based on the work he has being involved with, Karl found that 99% of garter snakes examined at a hibernaculum had empty stomachs. According to Karl the garter snakes must have empty stomachs during hibernation in order to avoid food rotting in their stomachs over winter. He says that dehydration is the main cause of mortality in over wintering snakes, rather than starvation.

Mason, Robert, T. – Department of Zoology, Oregon State University, Corvallis, Oregon, 97331-2914.

Bob believed that there was not much value in pit tagging since scale clipping accomplishes the same result (i.e. individual identification). He also recommended not to scale clip on the tail because of the small size of scales and possible loss of tail during interactions with predators. He prefers a Sclero Punch for making notches in the scutes of snakes.

Bob indicated that scales are not alive and will not grow back over the winter. When the scales do grow back there should be a white or light colored "scar" or tattoo where the scale was clipped.

Bob agreed with the method of both temporary holding practices used in our study (i.e. lab sinks and outdoor enclosures). He also feels it is a good idea to mix the snakes from the two sites prior to releasing the relocation snakes into the new den. However, he

figures that they will follow one another chemically regardless whether they were mixed or not.

Orchard, Stan, A. – Research Associate, Royal British Columbia Museum, 1745 Bank Street, Victoria British Columbia V8R 4V7.

Stan has researched and studied the homing abilities in translocated painted turtles in the southern Okanagan Valley of southcentral British Columbia.

Regarding our garter snake study he feels that the adult (relocated) garter snakes (if any) will most likely return to the original den site. This is due to the many years of imprinting on that sight (coupled with their strong and well-established natural homing instincts). He also feels of the relocated snakes, the adults will be the least likely to accept and adapt to the new (gravel pit) hibernaculum.

In terms of scale clipping snakes at the gravel pit hibernaculum, Stan feels it would be worthwhile for determining the extent, if any, of common use between the two hibernacula. He also pointed out that there may be a chance that snakes from the gravel pit den site may follow relocated snakes (if any) that successfully find their way back to their original den at the lawn site.

Porchuk, Ben - University of Guelph/private consultant, 82 Hunt Avenue, Richmond Hill, Ontario L4C 4G9.

Ben is involved with Blue Racer translocations, hibernaculum construction, and artificial nesting sites. Through correspondence, Ben has brought to attention several papers on the topics researched.

Powell, Larry – Department of Biological Sciences, University of Calgary, Calgary, Alberta, 2500 University Drive T2N 1N4

In regards to scale clipping, Larry recommended (based on his previous experiences with bull snakes and rattlesnakes) clipping the scales on the tail. This was to reduce possible fatal injuries to vital organs. However, Kendell and Takats (pers. comm.) found (in the case of garter snakes) that clipping the tail scutes limited the ease of reading the individual scale clip I.D. pattern due to their small size (especially on young snakes) of the scales. Also, the possible combination of scale clip patterns was limited because some scales were too small to clip, or were fused to the skin. In addition, some snakes had broken or damaged tails that made it impossible to mark them.

Larry provided information on a company (Avid Canada Ltd.) that sold PIT tags and he gave advice on which model of scissors worked best for scale clipping. Larry also indicated the best location for the pit tag as well as the technique for implantation. He recommended that pit tags be placed dorsally a few centimetres to one side of the spine anterior to the vent. Physiologically, this was the safest location for an implant due to a lack of vital organs in the area.

Finally, Larry recommended obtaining as much scientific and research data as possible while the snake is in hand (i.e. scale clip and/or pit tag, weigh, age, measure SVL and total length, note unique individual characteristics, and identify sex when possible).

Russell, Anthony, P. – Department of Biological Sciences, University of Calgary, 2500 University Drive, Calgary, Alberta T2N 1N4

Tony's direct experience with snakes involved the rattlesnake tagging study in Alberta. He proposed that the success of the translocation project would be measured by whether or not the relocated snakes return to the new den the following fall. He recommended marking the relocated snake a second time after emergence and a proportion (or all, if feasible) of the existing original population.

Takats, Lisa – Non game biologist, Alberta Conservation Association, 7th floor O. S. Longman Building, Edmonton, Alberta T6H 4P2.

Lisa is the co-ordinator of the Alberta Amphibian Monitoring Program, Alberta Snake Hibernaculum Project, and RANA (Researching Amphibian Numbers in Alberta). Recent work involving snakes includes the red-sided garter snake translocation study, initiated in the fall 1998, near Stony Plain, Alberta. This will be a two year study, completed in the spring, 2001.

SUMMARY OF CONTACTS

NAME	AFFILIATION	PHONE/FAX	E-MAIL
Didiuk, Andrew	CWS, Saskatoon, SK	(306) 975-4005/975-4089	andrew.didiuk@gc.ec.ca
Donald, Brett	Landowner, Stony Plain	(780) 963-6316	
Goater, Cam	University of Lethbridge	(403) 329-2752	goatcp@hg.uleth.ca
Gregory, Patrick, T.	University of Victoria	(250) 721-7103/721-7120	viper@uvic.ca
Hofman, Edward	F&W, Brooks	(403)-854-5544/854-5651	
Ilnicki, Brian	DU, Wainwright	(780) 842-5225(6176)	
Kendell, Kris	Wildlife Consultant	(780) 422-9536	kriskendell@hotmail.com
Koonz, Bill	NRS, Manitoba	(204) 945-6811	
Kunnas, Floyd	F&W, Cold Lake	(780) 645-9313/645-6206	
Larche, Ronald, A.	CWS, Manitoba	(204) 945-7740/945-3077	rlarche@nr.gov.mb.ca
Larsen, Karl	University of Victoria	(250) 828-5456	klarsen@cariboo.bc.ca
Mason, Robert	Oregon State University	(541) 737-4107	masonr@bcc.orst.edu
Orchard, Stan, A.	Royal BC Museum, BC	(250) 595-7556	sorchard@islandnet.com
Porchuk, Ben	University of Guelph	(905) 884-2940	bporchuk@yahoo.com
Powell, Larry	University of Calgary	(403) 220-2687/289-9311	lpowell@acs.ucalgary.ca
Russell, Anthony, P.	University of Calgary	(403) 220-5251	
Takats, Lisa	AB Conservation Assoc.	(780) 427-1249	lisa.takats@env.gov.ab.ca
Tuberville, Tracy	Savannah River Ecology		tuberville@srel.edu
Willson, Robert	University of Guelph		rwillson@uoguelph.ca

SYNTHESIS

In Alberta, there has been limited scientific long-term study regarding the translocation of snakes from one hibernaculum to another, existing or artificial. Extensive research has been undertaken in Alberta involving the Prairie Rattlesnake (*Crotalus viridis*) and garter snakes (*Thamnophis spp.*), primarily studying movement patterns and ecology. In Manitoba, considerable research has been conducted on the study of garter snakes, particularly regarding patterns of emergence, dispersal and orientation, life-history parameters, and ecology. In British Columbia, research conducted on garter snakes includes thermal ecology, natural history, and ecology. Canadian studies involving hibernacula include that of the Blue Racer (*Coluber constrictor foxii*) found on Pelee Island, Ontario, the Prairie Rattlesnake (*Crotalus viridis*) in Alberta, and garter snakes (*Thamnophis spp.*) in British Columbia, Alberta and Manitoba. The majority of research involving garter snakes in Canada is focussed on thermal and chemical ecology, orientation mechanisms and dispersal patterns, natural history, and ecology; including hibernation, reproduction, habitat use, and diet. There is extensive literature on tagging and marking snakes.

Although the Red-sided Garter Snake (*Thamnophis sirtalis parietalis*) and other garter snakes in Alberta are wide ranging, the majority of the populations are localized. Therefore, there is a need to protect existing populations and their centers of dispersal (i.e. hibernacula), in order to prevent these local populations from being extirpated. A successful translocation of garter snakes will provide management options for both "problem snakes" and land use issues, in Alberta and other provinces. In addition it will provide valuable information instrumental in reintroducing snakes to abandoned den sites or relocating snakes into artificial hibernacula.

Procedures and methods used in the Red-sided Garter Snake translocation study, near Stony Plain Alberta, have been discussed with various wildlife scientists throughout North America. These discussions have generated helpful advice and opinions regarding the translocation study.

Regarding this translocation study, all snakes have been captured by hand as they basked or were observed near the hibernaculum. All snakes captured were marked and had specific data collected on them. PIT (Passive Integrated Transponder) tags and scale clipping were

the two means used to mark individual snakes. The PIT tags, for the study were obtained from AVID Canada Ltd. (Powell, pers. comm.). PIT tags were implanted in the same location on each individual snake to ease identifying them. They were implanted dorsally approximately 3 cm posterior the vent to avoid areas of vital organs (Powell, pers. comm.). Scale clipping allowed for long-term, individual identification, by leaving notches and later light scars on the scutes of the snakes (Mason, pers. comm., Powell, pers. comm.). Surgical scissors where used to scale clip the scutes on the individual snakes because of their accuracy and precision (Larsen pers. comm., Powell, pers. comm.). An alternate, effective scale clipping tool, called a Sclero Punch, can be used (Mason pers. comm.); however scales were difficult to clip using this tool (Takats and Kendell, pers. comm.). All scale clip patterns were initiated no lower then the third scale from the vent and anterior to the vent (Larsen, pers. comm., Mason, pers. comm.). This was for two reasons: 1) to avoid any possible injuries to the vent area during the scale clipping process (Larsen pers. comm.) and, 2) to avoid any difficulties in reading scale clip patterns or problems regarding lost or damaged tails from interactions with predators (Mason, per. comm.). Scale clipping on tail scutes was avoided due to: 1) difficulty in reading individual identification patterns because of the small scale size, 2) difficulty in clipping the frequently fused scales (with no leading edge), and 3) difficulty maintaining a standardized scale clip pattern on lost or reduced tails. Prior to release, captured snakes where temporarily held in deep lab sinks (for processing and recording data), and later in outdoor enclosures (Mason, pers. comm.). The processed snakes were weighed, measured (SVL and total length), aged (YOY, subadult, adult) and examined for unique identifying characteristics (i.e. broken tails, scars, etc.) (Powell, pers. comm.). Due to difficulty in distinguishing male and female snakes based on tail length and probing, snakes were not sexed (Takats and Kendell, per. comm.).

Progress on, and the results of the translocation study will be published by Alberta Environmental Protection/Natural Resources Service and Alberta Conservation Association, in the future. Final evaluation of the study is scheduled for fall 2001.

LITERATURE REVIEW-SYNTHESIS

The following is a synthesis of the literature reviewed as it relates to various topics involving the ecology, management and conservation of the Red-sided Garter Snake (*Thamnophis sirtalis parietalis*) and other snake species.

ECOLOGY

Aleksiuk, M., and P. T. Gregory, 1974.
Blanchard, F. N., and F. C. Blanchard, 1941.
Blanchard, F. N., and F. C. Blanchard, 1942.
Carpenter, C. C. 1952.
Charland, M.B., and P. T. Gregory, 1995.
Cook, F. R. 1984.
Crews, D., and W. R. Garstka, 1982.
Doughty, P. 1994.
Ducks Unlimited Canada, 1993.
Fitch H. S. 1965.
Froom, B. 1972.
Garstka, W. R., B. Camazine, and D. Crews, 1982.
Gregory, P. T. 1974a.
Gregory, P. T. 1975.
Gregory, P. T. 1977.
Gregory, P. T. 1983.
Gregory, P. T. 1984b.
Gregory, P. T. 1984c.
Gregory, P. T., K. W. Larsen, and D. R. Farr, 1992.
Hawley, A. W. L., and M. Aleksiuk, 1975.
Joy, J.E., and D. Crews, 1986.
Kaplan, M. 1996.
Kephart, D. G. 1981.
Kephart, D. G., and S. J. Arnold, 1982.
Krohmer, R. W., M. Grassman, and D. Crews, 1987.
Larsen, K. W. 1986.
Larsen, K. W., P. T., Gregory, and R. Antoniak, 1993.
Manjarrez, J., and H. Drummond, 1996.
Peterson, C. R. 1987.
Preston, W. B. 1982.
Rossman, D. A., N. B. Ford, and R. A. Seigel, 1996.
Russell, A. P., and A. M. Bauer, 1993.
Stebbins, R. C. 1985.
Whittier, J. M., R. T. Maison, and D. Crews, 1985.

TRANSLOCATION/RELOCATION

Braithwaite, A. C. 1995.
MacMillan, S. 1995.
McNally, J., T. A. Hare, and J. Jarchow, 1996.
Reinert, H. K. 1991.

HIBERNAUCULA/HIBERNATION

Aleksiuk, M. 1976a.
Bailey, R. M. 1949.
Carpenter, C. C. 1953.
Chruchill, T. A., and K. B. Storey, 1991.
Chruchill, T. A., and K. B. Storey, 1992.
Costanzo, J. P. 1986.
Costanzo, J. P. 1988.
Costanzo, J. P. 1989b.
Costanzo, J. P. 1989c.
Fisher, S. 1998.
Gillingham, J. C., and C. C. Carpenter, 1978.
Graves, B. M., and D. Duvall, 1990.
Graves, B. M., D. Duvall, M. B. King, S. L. Lindstedt, and W. A. Gern, 1986.
Gregory, P. T. 1974b.
Gregory, P. T. 1975.
Gregory, P. T. 1982.
Gregory, P. T. 1984a.
Gregory, P. T. 1990.
Gregory, P. T., and K. W. Stewart, 1975.
Hawley, A. W. L., and M. Aleksiuk, 1975.
Kaplan, M. 1996.
Larsen, K. W., and J. F. Hare, 1992.
Macartney, J. M., K. W. Larsen, and P. T. Gregory, 1989.
MacMillan, S. 1988.
Nero, R. W. 1957.
Rossman, D. A., N. B. Ford, and R. A. Seigel, 1996.
Russell, A. P., and A. M. Bauer, 1993.
Sexton, O. J., and J. E. Bramble, 1994.
Storey, K. B., and J. M. Storey, 1997.
Van-het Meer, J. 1996.
Vincent, T. 1975
Woodbury, A. M. 1951.
Zappalorti, R. T., and G. Rocco, 1991.
Zappalorti, R. T., and H. K. Reinert, ????.

DISPERSAL, ORIENTATION AND MOVEMENTS (CHEMICAL ECOLOGY)

Charland, M.B., and P. T. Gregory, 1995.
Costanzo, J. P. 1989a.
Fitch, H. S. 1965.
Graves, B. M., M. Halpern, and J. C. Gillingham, 1993.
Heller, S., and M. Halpern, 1981.
Hirth, H. F., R. C. Pendleton, A. C. King, and T. R. Downard, 1969.
Larsen, K. W. 1987.
Lawson, P. A. 1989.
Lawson, P. A. 1991.
Lawson, P. A. 1991.
Lawson, P. A. 1994.
Rossman, D. A., N. B. Ford, and R. A. Seigel, 1996.
Waters, R. M. 1993.

CAPTURE AND MARKING TECHNIQUES

Blanchard, F. N., and E. B. Finster, 1933.
Brenner, F. J., E. K. Brenner, and P. E. Brenner, 1992.
Brown, W. S. 1976.
Campbell, H. W., and S. P. Christman, 1982.
Dargan, L. M., and W. H. Stickel, 1949.
Ferner, J W. 1979.
Fitch, H. S. 1951.
Hudnall, J. A. 1982.
Keck, M. B. 1994.
Lewke, R. R., and R. K. Stroud, 1974.
Lutterschmidt, W. I. 1994.
Perterson, C. R. 1987.
Porchuk, B. 1997.
Stark, M. A. 1985.
Stark, M. A. 1986.

REFERENCES

Alberta Environmental Protection. 1996a. The Wildlife Act. Alberta Environmental Protection, Natural Resources Service. 212 pp.

Alberta Environmental Protection. 1996b. The status of Alberta wildlife. Alberta Environmental Protection, Natural Resources Service, Wildlife Management Division Report. Edmonton, AB. 44 pp.